

PRELIMINARY DATA SHEET

SKY77590-51 Tx-Rx FEM for Quad-Band GSM/ GPRS/ EDGE with Six Linear TRx Switch Ports and Dual-Band TD-SCDMA

Applications

- Quad-band GSM/EDGE and Dual-Band TD-SCDMA cellular handsets encompassing
 - Class 4 GSM850/900
 - Class 1 DCS1800/PCS1900
 - Class 12 GPRS multi-slot operation
 - 6 low insertion loss / high linearity interchangeable TRx switch ports
 - Linear EDGE operation
 - TD-SCDMA Bands 34/39

Features

- Small, low profile package
 - 6 mm x 6 mm x 0.85 mm
 - 28-pad configuration
- Low input power range -1 dBm to 6 dBm
- High efficiency
- 40% GSM850
- 40% GSM900
- 35% DCS1800
- 35% PCS1900
- Tx-VCO-to-antenna and antennato-Rx-SAW filter RF interface
- Tx harmonics below -38 dBm
- Current limiting for over-voltage protection and extended battery life
- \bullet Input/Output matched internally to 50 Ω
- High impedance control inputs: 20 µA, maximum
- Power control circuitry built-in for improved TRP variation



Skyworks Green[™] products are compliant with all applicable legislation and are halogen-free. For additional information, refer to Skyworks *Definition of Green*[™], document number SQ04-0074.

Description

SKY77590-51 is a transmit and receive Front End Module (FEM) designed in a very low profile (0.9 mm) and compact form factor for quad-band cellular handsets comprising GSM850/900, DCS1800, and PCS1900 operation and dual-band TD-SCDMA bands 34 and 39 operation — a complete transmit VCO-to-Antenna and Antenna-to-receive SAW filter solution. The FEM also supports Class 12 General Packet Radio Service (GPRS) multi-slot operation and linear EDGE operation. 3G switch-through support is provided by six dedicated high-linearity ports.

The module consists of a GSM850/900 PA and DCS1800/PCS1900/TD-SCDMA PA block, impedance-matching circuitry for 50 Ω input and output impedances, Tx harmonic filtering, a high linearity/low insertion loss switch, and a CMOS Power Amplifier Control (PAC) block. A custom silicon integrated circuit contains decoder circuitry to control the RF switch while providing a low current, external control interface.

Fabricated in InGaP/GaAs, the Heterojunction Bipolar Transistor (HBT) PA blocks support the GSM850/900 bands and DCS1800/PCS1900 bands and TD-SCDMA bands 34/39. Both PA blocks share common power supply pads to distribute current. The output of the PA block and the outputs to the six receive pads connect to the antenna pad through a high-linearity antenna switch. The 3G and Rx ports feature a 0 volts DC offset level which eliminates the need for external blocking capacitors. The InGaP/GaAs die, switch die, Silicon (Si) controller die, and passive components are mounted on a multi-layer laminate substrate and the entire assembly is encapsulated with plastic overmold.

RF input and output ports of the SKY77590-51 are internally matched to a 50 Ω load to reduce the number of external components on the phone board. Extremely low leakage current of the FEM maximizes handset standby time. Control of transmit and receive RF signal flows, and band selection are performed by four external control pads (see Figure 1 on overleaf). Mode of operation, Tx vs. Rx, and Band (GSM850, GSM900, DCS1800, PCS1900, and Bands 34/39) are controlled with the four logic inputs: Mode, TxEN, BS1, and BS2. Proper timing of the TxEN input and the VRAMP input ensures high isolation between the antenna and Tx-VC0 while the VC0 is being tuned prior to the transmit burst.

The integrated power amplifier control (PAC) function provides envelope amplitude control while reducing sensitivity to input drive, temperature, power supply, and process variation. Output power variation into mismatch is minimized with Skyworks' True Power control circuit.



FIGURE 1. SKY77590-51 FUNCTIONAL BLOCK DIAGRAM

Electrical Specifications

The following tables list the electrical characteristics of the SKY77590-51 Front-End Module. Table 1 lists the absolute maximum ratings and Table 2 lists the recommended operating conditions. Table 5 through Table 15 provide the electrical characteristics of the SKY77590-51 for modes GSM850, GSM900,

DCS1800, PCS1900, TD-SCDMA Bands 34/39, and 3G including control logic descriptions for the various modes.

The SKY77590-51 is a static-sensitive electronic device and should not be stored or operated near strong electrostatic fields. Detailed information on device dimensions, pad descriptions, packaging and handling can be found in later sections of this data sheet.

TABLE 1. ABSOLUTE MAXIMUM RATINGS

Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit at a time and all other parameters set at or below their nominal value.

Parameter	Symbol	Minimum	Nominal	Maximum	Unit	
Input Power		Pin			15	dBm
Supply Voltage \leq 1 μ s (measured to GND)		VBATT			6	V
DC Continuous During Burst ¹		IBATT	_		2.5	А
Burst Duty Cycle		Dв	_		50	%
Voltage Standing Wave Ratio	VSWR	_		20:1	V	
Power Control Voltage		VRAMP	-0.3		VBATT	V
Transmit Enable Voltage		VTXEN	-0.3		See Footnote ²	V
Mode Control Voltage	Vmode	-0.3		See Footnote ²	V	
Band Select Control Voltage		VBS1, VBS2	-0.3		See Footnote ²	V
Temperatures	Operating	TCASE	-30		+100	°C
	Storage	Тѕтс	-40		+150	
Moisture Sensitivity Level		MSL	_		3	
Reflow Solder Temperature (J-STD-020B)		TSOLDER	260	_	_	°C

¹ Applied voltage must be current-limited to specified range.

² The lesser of VCC or 2.9 V.

Parameter		Symbol	Minimum	Typical	Maximum	Unit
Supply Voltage ¹	GMSK	VBATT	3.0	3.5	4.6	V
	EDGE/ TD-SCDMA		3.0	3.6	4.6	
		Vcc	2.5	—	4.6	
Supply Current		Іватт	0	—	2.3	А
Operating Case Temperature ²	1-Slot (12.5% duty cycle)	TCASE	-20	_	+85	°C
	2-Slot (25% duty cycle)		-20	—	+85	
	3-Slot (37.5% duty cycle)		-20	—	+85	
	4-Slot (50% duty cycle)		-20	—	+85	

TABLE 2. RECOMMENDED OPERATING CONDITIONS

Unless otherwise specified: -20 °C \leq TCASE \leq +85 °C; 3.0 V \leq VBATT \leq 4.6 V.

¹ VBATT and VCC should be commoned unless DC/DC is used and VCC can be separately supplied.

² Case Operating Temperature refers to the temperature at the GROUND PAD on the underside of the package.

TABLE 3. SKY77590-51 INTERFACE IMPEDANCES

Paran	neter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Impedance System	n for All RF Ports	Z_rf		—	50		
Resistance of: TxEN, BS1, BS2, M	IODE	R_gpio	DC resistance to ground	—	200	—	kΩ
Capacitance of: TxEN, BS1, BS2, M	IODE	C_gpio	Capacitance to ground	—	—	2	pF
Current Consumpti TxEN, BS1, BS2, M	ion of: IODE	I_gpio	V_GPI0 < 2.9 V TCASE = +25 °C VBATT = 3.6 V	_	_	20	μA
Input Logic Level	Low	V_IL		-0.1	_	0.4	V
	High	V_ih		1.2		2.9	V
Burst Duty Cycle		Dв		12.5		50	%
Resistance of VRAM	IP	R_vramp	DC resistance to ground	—	200	_	kΩ
Capacitance of VRA	MP	C_vramp	Capacitance to ground	—	_	2	pF
Current Consumpti	ion of Vramp	I_vramp	Vramp < 1.45 V	—	_	15	μA
Power Control Volta	age	Vramp		0.2	_	1.6	V
Standby Current		I_STANDBY	All control lines = 0 V VBATT = 3.5 V TCASE = $+25$ °C	_	_	20	μA
Rx/3G Current		I_Rx/3G	Rx/3G Mode TCASE = +25 °C	—	_	500	μA
Switching Times I	Mode switching time	T_mode	EDGE to GMSK Mode defined as time from mode transition to application of GMSK RF input drive to meet forward isolation PESE	_	_	2	μs
E t	Band switching time	T_band	Time required for output power to settle within 0.5 dB of final value after band switch (PiN and VRAMP already applied prior to BS change)	—	—	2	
E t	Bias switching time	T_BIAS	Time required for EDGE gain to settle within 0.5 dB of final value	-		1	

Unless otherwise specified: -20 °C \leq TCASE \leq +85 °C; 3.0 V \leq VBATT \leq 4.6 V

Mode	Input Control Bits							
	TxEN	MODE	BS1	BS2				
Standby	0	0	0	0				
LB_GMSK_Tx	1	0	0	1				
HB_GMSK_Tx	1	0	1	1				
LB_EDGE_Tx	1	1	0	1				
HB_EDGE_Tx	1	1	1	1				
TRx1	0	1	0	0				
TRx2	0	1	1	0				
TRx3	0	1	0	1				
TRx4	0	1	1	1				
TRx5	0	0	1	0				
TRx6	0	0	0	1				
TD-SCDMA	1	1	1	1				

TABLE 4. SKY77590-51 MODE CONTROL LOGIC

TABLE 5. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8;–20 °C \leq Tcase \leq +85	°C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.	

GSM850/900 GMSK Mode							
Parameter		Symbol	Conditions	Minimum	Typical	Maximum	Unit
Frequency Range	GSM850	f		824		849	MHz
	GSM900			880	—	915	
Input Power		Pin	_	-1	—	6	dBm
Supply Voltage		VBATT	—	3.0	3.5	4.6	V
		Vcc	—	2.5	_	4.6	
Supply Current		Іватт	—	—	_	2.3	А
Power Added Efficiency	GSM850	PAE	$V_{BATT} = 3.5 V$ $P_{IN} = 3 dBm$	_	40	_	%
GSMS	GSM900		VRAMP = MAX VRAMP' Duty cycle = 1:8 Tcase = +25 °C	_	40	—	
Harmonics		2fo to 15fo	$\begin{array}{l} BW=3\;MHz\\ 5\;dBm\leqPouT\leq33\;dBm \end{array}$		-40	-34	dBm
Output Power		Pout_gmsk	PIN = -1 dBm VBATT = 3.5 V VRAMP = 1.6 V TCASE = +25 °C	33.3	34.0	_	dBm
		Pout_gmsk_ex	Pin = -1 dBm Vbatt = 3.0 V Vramp = 1.6 V	31.0	—	_	
Input VSWR		ΓIN	Pout \leq 33 dBm	—	—	2.5:1	
Isolation		ISO_pdsd	$\label{eq:response} \begin{array}{l} P_{IN} \leq 6 \; dBm \\ TxEN < 0.4 \; V \\ BS2 = Logic \; High \\ V_{RAMP} \leq 0.1 \; V \end{array}$	_	-62	-46	dBm
		ISO_pese	$\label{eq:product} \begin{array}{l} P_{IN} \leq 6 \ dBm \\ TxEN \geq 1.2 \ V \\ BS2 = Logic \ High \\ V_{RAMP} \leq 0.1 \ V \end{array}$	_	—	-10	

TABLE 5. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8;–20 °C \leq TCASE \leq +85 °C	C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.	

GSM850/900 GMSK Mode								
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit		
Low Power Current	I_low_gmsk	Pın ≤ 6 dBm Pou⊤ = 5 dBm	—		120	mA		
Stability	Stab	All combinations of the following parameters: $5 \text{ dBm} \le P_{OUT} \le 33 \text{ dBm}$ $-1 \text{ dBm} \le P_{IN} \le 6 \text{ dBm}$ Load VSWR = 15:1, all phase angles	No	parasitic osc	illation > –36	dBm		
Load Mismatch	Load	All combinations of the following parameters: $5 \text{ dBm} \le P_{OUT} \le 33 \text{ dBm}$ $-1 \text{ dBm} \le P_{IN} \le 6 \text{ dBm}$ Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation					
Noise Power	PNOISE_850	f_0 + 20 MHz (869 MHz to 894 MHz) Pout \leq 33 dBm Vbatt \leq 3.5 V Tcase = +25 °C RBW = 100 kHz	_	_	-83	dBm		
	PNOISE_900	$f_0 + 20 \text{ MHz}$ $P_{OUT} \le 33 \text{ dBm}$ $V_{BATT} \le 3.5 \text{ V}$ $T_{CASE} = +25 ^{\circ}\text{C}$ RBW = 100 kHz	_	_	-83			
		$f_0 + 10 \text{ MHz}$ $P_{OUT} \le 33 \text{ dBm}$ $V_{BATT} \le 3.5 \text{ V}$ $T_{CASE} = +25 \text{ °C}$ $RBW = 100 \text{ kHz}$	_	_	-79			
		$f_0 - 1805 \text{ MHz to } 1880 \text{ MHz}$ $P_{OUT} \le 33 \text{ dBm}$ $V_{BATT} \le 3.5 \text{ V}$ $T_{CASE} = +25 ^{\circ}\text{C}$ RBW = 100 kHz	_	_	-86			

¹ MAX VRAMP = VRAMP at POUT = 33 dBm, 50 Ω load, TCASE =+25 °, VBATT = 3.5 V, PIN = 3dBm.

TABLE 6. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq Tcase \leq +8;	5 °C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.	

GSM850/900 EDGE Mode							
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit	
Frequency Range GSM850	f	_	824	_	849	MHz	
EDGE900	-		880	_	915		
Supply Voltage	VBATT	_	3.0	3.6	4.6	V	
	Vcc	—	2.5	_	4.6		
Power Added Efficiency	PAE	VBATT = 3.6 V VRAMP = 1.45 V POUT = 27.5 dBm TCASE = +25 °C	_	20	_	%	
Harmonics	2fo to 15fo	$\begin{array}{l} \text{BW}=3 \text{ MHz} \\ \text{5 dBm} \leq \text{Pout} \leq 27.5 \text{ dBm} \end{array}$	—	-45	-36	dBm	
Output Power	Pout_edge	VBATT = 3.6 V VRAMP = 1.45 V TCASE = +25 °C ACPR / EVM / ORFS in specification	27.5		—	dBm	
	Pout_edge_ex	VBATT = 3.0 V VRAMP = 1.45 V ACPR / EVM / ORFS in specification	26.0	_	_		
Input VSWR	ΓIN	$Pout \le 27.5 \text{ dBm}$	—		3:1		
Gain	G_NOM_850	Vbatt = 3.6 V Pout = 27.5 dBm	31.1	32.8	34.4	dB	
	G_NOM_900	VRAMP = 1.45 V TCASE = +25 °C	30.7	32.4	34.0		
	G_EX_850	Pout = Pout_edge, Pout_edge_ex Vramp = 1.45 V	29.3	32.8	35.8		
	G_ex_900		29.0	32.4	35.4		
ACPR	ACPR_200	Pout = Pout_edge, Pout_edge_ex		_	-34	dBc	
	ACPR_400	Bandwidth = 30 kHz VRAMP = 1.45 V		_	-58		
	ACPR_600			_	-64		
EVM	EVM_RMS	$\begin{array}{l} \mbox{Pout} = \mbox{Pout}_\mbox{edge}, \mbox{Pout}_\mbox{edge}_\mbox{ex} \ V \\ \mbox{Vramp} = 1.45 \ V \end{array}$	—	—	5	%	
Isolation	ISO_E_PDSD	$P_{IN} = -45 \text{ dBm}$ $TxEN < 0.4 \text{ V}$ $BS2 = \text{Logic High}$ $V_{RAMP} \le 0.1 \text{ V}$			-60	dBm	

TABLE 6. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq Tcase \leq +85 °C	C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.	

GSM850/900 EDGE Mode							
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit	
Low Power Current	I_LOW_EDGE	VBATT = 3.6 V VRAMP = 0.4 V POUT = 5 dBm	-	—	140	mA	
Stability	Stab	All combinations of the following parameters: 5 dBm \leq Pout \leq 27.5 dBm Load VSWR = 15:1, all phase angles	No	parasitic osc	illation > –36	dBm	
Load Mismatch	Load	All combinations of the following parameters: VRAMP = controlled 5 dBm \leq Pout \leq 27.5 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation				
Noise Power	PNOISE_850	fo + 20 MHz (869 MHz to 894 MHz) Pout ≤ 27.5 dBm VBATT = 3.6 V TCASE = +25 °C RBW = 100 kHz	_	_	-82	dBm	
	PNOISE_900	fo + 20 MHz $Pout \le 27.5 \text{ dBm}$ VBATT = 3.6 V TCASE = +25 °C RBW = 100 kHz		_	-82		
		fo + 10 MHz $Pout \le 27.5 \text{ dBm}$ VBATT = 3.6 V TCASE = +25 °C RBW = 100 kHz	_	_	-82		
		fo = 1805 MHz to 1880 MHz $Pout \le 27.5 \text{ dBm}$ VBATT = 3.6 V TCASE = +25 °C RBW = 100 kHz	_	_	-86		

TABLE 7. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq TCASE \leq +8	35 °C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.	

GSM1800/1900 GMSK Mode								
Paramete	r	Symbol	Conditions	Minimum	Typical	Maximum	Unit	
Frequency Range	DCS1800	f	_	1710	—	1785	MHz	
	PCS1900		_	1850		1910		
Input Power		Pin	_	-1		6	dBm	
Supply Voltage		VBATT	_	3.0	3.5	4.6	V	
		Vcc	_	2.5	—	4.6		
Power Added Efficiency	I	PAE_GSM1800	$V_{BATT} = 3.5 V$ $P_{IN} = 3 dBm$	—	35		%	
		PAE_GSM1900	→ VRAMP = MAX VRAMP ¹ Duty cycle = 1:8 Tcase = +25 °C	—	35			
Harmonics		2fo to 7fo	$\begin{array}{l} BW = 3 \; MHz \\ 0 \; dBm \leq Pout \leq 31 \; dBm \\ 50 \; \Omega \end{array}$		-40	-34	dBm	
Output Power		Pout_gmsk	$\label{eq:Pin} \begin{array}{l} Pin = -1 \; dBm \\ VBATT = 3.5 \; V \\ VRAMP = 1.6 \; V \\ TCASE = +25 \; ^\circC \end{array}$	31.0	31.4	_	dBm	
		Pout_gmsk_ex	Pin = -1 dBm Vbatt = 3.0 V Vramp = 1.6 V	28.5	—	_		
Input VSWR		Гіл	Pouτ ≤ 31 dBm	_	—	2.5:1		
Isolation		ISO_pdsd	$\label{eq:PIN} \begin{array}{l} P_{IN} \leq 6 \; dBm \\ TxEN < 0.4 \; V \\ BS2 = Logic \; High \\ V_{RAMP} \leq 0.1 \; V \end{array}$	_	-52	-46	dBm	
		ISO_pese	$\label{eq:pinel} \begin{array}{l} Pin \leq 6 \ dBm \\ TxEN \geq 1.2 \ V \\ BS2 = Logic \ High \\ V_{RAMP} \leq 0.1 \ V \end{array}$	_	_	-10		
Low Power Current		I_low_gmsk	$P_{IN} \le 6 \ dBm$ $P_{OUT} = 0 \ dBm$	-	—	100	mA	

TABLE 7. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq TCASE \leq +85 °C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM1800/1900 GMSK Mode							
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit	
Stability	Stab	All combinations of the following parameters: 0 dBm \leq Pout \leq 31 dBm -1 dBm \leq PiN \leq 6 dBm Load VSWR = 15:1, all phase angles	No parasitic oscillation >-36 dBm				
Load Mismatch	Load	All combinations of the following parameters: 0 dBm \leq Pout \leq 31 dBm -1 dBm \leq PiN \leq 6 dBm Load VSWR = 20:1, all phase angles.	No module damage or permanent degradation			legradation	
Noise Power	PNOISE_1800	$f_0 + 20 \text{ MHz}$ $P_{OUT} \le 31 \text{ dBm}$ $V_{BATT} = 3.5 \text{ V}$ $T_{CASE} = +25 \text{ °C}$ RBW = 100 kHz	-	_	-83	dBm	
		$f_0 = 925$ MHz to 960 MHz Pout ≤ 31 dBm VBATT = 3.5 V TCASE = +25 °C RBW = 100 kHz	-	_	-84		
	PNOISE_1900	fo + 20 MHz $Pout \le 31 \text{ dBm}$ VBATT = 3.5 V TCASE = +25 °C RBW = 100 kHz	_	_	-83		
		fo = 869 MHz to 894 MHz $Pout \le 31 \text{ dBm}$ VBATT = 3.5 V TCASE = +25 °C RBW = 100 kHz	-	_	-84		

¹ MAX VRAMP = VRAMP at POUT = 31 dBm, 50 Ω load, TCASE =+25 °, VBATT = 3.5 V, PIN = 3dBm.

TABLE 8. SKY77590-51 ELECTRICAL CHARACTERISTICS (1 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq Tcase \leq +8;	5 °C;
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.	

GSM1800/1900 EDGE Mode								
Parameter		Symbol	Conditions	Minimum	Typical	Maximum	Unit	
Frequency Range	EDGE1800	f	_	1710	—	1785	MHz	
	EDGE1900			1850	_	1910		
Supply Voltage		VBATT	_	3.0	3.6	4.6	V	
		Vcc	_	2.5	—	4.6		
Power Added Efficiency		PAE_gsm1800	Vbatt = 3.6 V Vramp = 1.45 V	—	22	_	%	
		PAE_gsm1900	Pout = 26.5 dBm TCASE = +25 °C	_	22	_		
Harmonics		2fo to 7fo	$\begin{array}{l} BW = 3 \text{ MHz} \\ 0 \text{ dBm} \leq \text{Pout} \leq 26.5 \text{ dBm} \end{array}$	-	-45	-36	dBm	
Output Power		Pout_edge	$\label{eq:VBATT} \begin{array}{l} VBATT = 3.6 \text{ V} \\ VRAMP = 1.45 \text{ V} \\ TCASE = +25 \ ^\circ C \\ ACPR \ / \ EVM \ / \ ORFS \ \text{in specification} \end{array}$	26.5	_	_	dBm	
		Pout_edge_ex	VBATT = 3.0 V VRAMP = 1.45 V ACPR / EVM / ORFS in specification	25.0	—	_		
Input VSWR		ΓΙΝ	Pout $\leq 26.5 \text{ dBm}$	—	—	3:1		
Gain		G_NOM_1800	Vbatt = 3.6 V Pout = 26.5 dBm	32.3	34.1	36.0	dB	
		G_NOM_1900	$V_{RAMP} = 1.45 V$ TCASE = +25 °C	31.2	33.0	34.9		
		G_EX_1800	Pout = Pout_edge, Pout_edge_ex Vramp = 1.45 V	30.6	34.1	37.4		
		G_EX_1900		29.5	33.0	36.3		
ACPR		ACPR_200	Pout = Pout_edge, Pout_edge_ex	—	_	-34	dBc	
		ACPR_400	Bandwidth = 30 kHz VRAMP = 1.45 V	—	—	-58		
		ACPR_600		—	_	-64		
EVM		EVM_RMS	Pout = Pout_edge, Pout_edge_ex Vramp = 1.45 V	—	—	5	%	
Isolation		ISO_E_pdsd	$\label{eq:PiN} \begin{array}{l} P_{IN} = -45 \ dBm \\ TxEN < 0.4 \ V \\ BS2 = Logic \ High \\ V_{RAMP} \leq 0.1 \ V \end{array}$	—	—	-60	dBm	
Low Power Current		I_LOW_EDGE	Pout = 0 dBm Vbatt = 3.6 V Vramp = 0.4 V	—	—	140	mA	

TABLE 8. SKY77590-51 ELECTRICAL CHARACTERISTICS (2 OF 2)

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq TCASE \leq +85 °C
3.0 \leq VBATT \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.

GSM1800/1900 EDGE Mode							
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit	
Stability	Stab	All combinations of the following parameters: 0 dBm \le Pout \le 26.5 dBm Load VSWR = 15:1, all phase angles	No	No parasitic oscillation >–36 dBm			
Load Mismatch	Load	All combinations of the following parameters: 0 dBm \leq Pout \leq 26.5 dBm Load VSWR = 20:1, all phase angles	No modu	No module damage or permanent degradation			
Noise Power	PNOISE_1800	$f_0 + 20 \text{ MHz}$ $P_{OUT} \le 26.5 \text{ dBm}$ $V_{BATT} = 3.6 \text{ V}$ $T_{CASE} = +25 \text{ °C}$ RBW = 100 kHz	_	_	-80	dBm	
		$f_0 = 925 \text{ MHz to } 960 \text{ MHz}$ $P_{OUT} \le 26.5 \text{ dBm}$ $V_{BATT} = 3.6 \text{ V}$ $T_{CASE} = +25 \text{ °C}$ RBW = 100 kHz	_	_	-84		
	PNOISE_1900	$f_0 + 20 \text{ MHz}$ $P_{0UT} \le 26.5 \text{ dBm}$ $V_{BATT} = 3.6 \text{ V}$ $T_{CASE} = +25 \text{ °C}$ RBW = 100 kHz	_	_	-80		
		fo = 869 MHz to 894 MHz $Pout \le 26.5 \text{ dBm}$ VBATT = 3.6 V TCASE = +25 °C RBW = 100 kHz	_	_	-84		

SKY77590-51 Tx-Rx FEM FOR QUAD-BAND GSM / GPRS / EDGE with SIX LINEAR TRx SWITCH PORTS and DUAL-BAND TD-SCDMA

Parameters	6	Symbol	Condition	Minimum	Typical	Maximum	Unit			
Output Power		Роит	HPM VBATT = 3.4 V	24	—	—	dBm			
Gain		Снісн	Pout = 24 dBm Vramp = 1.45 V	31.0	32.5	34.0	dB			
Power Added Efficiency		РАЕнідн	Pout = 24 dBm Vramp = 1.45 V	—	12.5	—	%			
Total Supply Current		Ісс_нівн	$\begin{array}{l} Pout=24 \; dBm \\ Vramp=1.45 \; V \end{array}$	—	570	670	mA			
Adjacent Channel Leakage power Ratio ¹	1.6 MHz offset	ACLR1.6	Pout = 24 dBm Vramp = 1.45 V	—	-41	-37	dBc			
	3.2 MHz offset	ACLR3.2	Pout = 24 dBm Vramp = 1.45 V	—	-63	-55				
Harmonic Suppression	Second	f02	$Pout \leq 24 \; dBm$	_	—	-36	dBm			
	Third	f03		—	—	-46				
Tx Noise in Rx Bands	DCS Rx		1805 MHz–1850 MHz	—	—	-131	dBm/Hz			
Input Voltage Standing Wave	Ratio	VSWR	—	_	—	3.0:1	—			
EVM		EVM	Pout = 24 dBm Vramp = 1.45 V	-	2	4	%			
Rise / Fall Time	DC	TONDC	—	—	8	10	μs			
		TOFFDC	—	—	8	10				
	RF	TonRF	_		3	6				
		TOFFRF	_		3	6				
Stability (Spurious output)		S	5:1 VSWR All phases		—	-65	dBc			
Ruggedness - no damage ²		Ru	Pout	10:1	—	—	VSWR			

TABLE 9. SKY77590-51 ELECTRICAL SPECIFICATIONS FOR TD-SCDMA NOMINAL OPERATING CONDITIONS (1880–1920 MHz) Unless otherwise specified; per Table 2 over dynamic range up to 24 dBm output power.

¹ ACLR is expressed as a ratio of total adjacent power to TD-SCDMA modulated in-band, both measured in 1.28 MHz bandwidth at specified offsets and 16% duty cycle.

² All phases, time = 10 seconds.

Parameters		Symbol	Condition	Minimum	Typical	Maximum	Unit		
Gain		Gніgh	Pout = 24 dBm Vramp = 1.45 V	29.7	31.2	32.7	dB		
Power Added Efficiency		PAEhigh	Pout = 24 dBm Vramp = 1.45 V	_	11	—	%		
Total Supply Current		Ісс_нісн	Pout = 24 dBm Vramp = 1.45 V		630	750	mA		
Adjacent Channel Leakage 1.6 MHz offset power Ratio ²		ACLR1.6	Pout = 24 dBm Vramp = 1.45 V	-	-40	-37	dBc		
	3.2 MHz offset	ACLR3.2		—	-60	-55			
Harmonic Suppression	Second	f02	$P_{OUT} \le 24 \text{ dBm}$	_	_	-40	dBm		
	Third	f03		_	_	-46			
Tx Noise in Rx Bands	DCS Rx		1805 MHz–1880 MHz	_	—	-131	dBm/Hz		
Input Voltage Standing Wave R	atio	VSWR	_	_	_	3.0:1			
EVM		EVM	Pout = 24 dBm Vramp = 1.45 V	-	2	4	%		
Rise / Fall Time	DC	TONDC	—	—	8	10	μs		
		TOFFDC	_	—	8	10			
	RF	TonRF	—	—	3	6			
		TOFFRF	_	—	3	6			
Stability (Spurious output)		S	5:1 VSWR All phases	_	_	-65	dBc		
Ruggedness - no damage ²		Ru	Pout ≤ 24 dBm	10:1	—	—	VSWR		

 TABLE 10. SKY77590-51 ELECTRICAL SPECIFICATIONS FOR TD-SCDMA NOMINAL OPERATING CONDITIONS (2010–2025 MHz)

 Unless otherwise specified: per Table 2 over dynamic range up to 24 dBm output power.

¹ ACLR is expressed as a ratio of total adjacent power to TD-SCDMA modulated in-band, both measured in 1.28 MHz bandwidth at specified offsets and 16% duty cycle.

^{2.} All phases, time = 10 seconds.

TABLE 11. SKY77590-51 ELECTRICAL CHARACTERISTICS

Unless otherwise specified: 50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 4:8; –20 °C \leq TcAse \leq +85 °C
3.0 \leq Vbatt \leq 4.6 V; Terminate all unused RF ports with 50 Ω during test.

Ports TRx1 to TRx6 Tx-Rx Mode							
Para	meter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Frequency Range	3G_Tx/Rx	f_3G_Tx/Rx	_	824	_	2690	MHz
Insertion Loss ANT – 3G_Tx/	ANT – 3G_Tx/Rx	3G_Tx/Rx	824 MHz to 960 MHz TCASE =+25°C	_	0.60	0.95	dB
			1710 MHz to 1990 MHz TCASE =+25°C	-	0.70	0.95	
			2110 MHz to 2690 MHz TCASE =+25°C	-	1.00	1.20	
Isolation	ADJACENT		Ports TRx1 through TRx6 to any other ADJACENT port (824–960 MHz)	25	—	—	dB
			Ports TRx1 through TRx6 to any other ADJACENT port (1710–1990 MHz)	25	—	—	
			Ports TRx1 through TRx6 to any other ADJACENT port (2110–2690 MHz)	20	—	-	
	NON-ADJACENT		Ports TRx1 through TRx6 to any other NON-ADJACENT port (824–960 MHz)	30	—	—	
			Ports TRx1 through TRx6 to any other NON-ADJACENT port (1710–1990 MHz)	30	—	—	
			Ports TRx1 through TRx6 to any other NON-ADJACENT port (2110–2690 MHz)	20	—	—	
IMD2	fRx — f Tx		Tx Output Power = 20 dBm	_		-95	dBm
	fRx + f Tx		Blocker Power = -15 dBm Blocker frequency impedance is swept over all	—	—	-95	
IMD3	2fTx - fRx		phase angles at the WCDMA port. (Minimum VSWR	—	—	-97	
	$2f_{\text{Rx}} - f_{\text{Tx}}$		at blocker is 10:1 to model out-of-band duplexer impedance.	_	_	-97	
Leakage from Tx 1	to TRx Ports	P_TRx	—	_	—	5	dBm

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¹Test condition: $V_{CC} = 3.4 \text{ V}$, $T_{CASE} = +25 \text{ °C}$

FIGURE 2. MARGIN-TO-SEM CHART

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Technical Information



FIGURE 3. SKY77590-51 APPLICATION SCHEMATICS

Package Dimensions

The SKY77590-51 guad-band front-end module is a 6 mm x 6 mm x 0.9 mm, 28-pad, leadless package. Figure 4 is a threeview mechanical drawing of the pad configuration with layout

SKY77590-51 Tx-Rx FEM FOR QUAD-BAND GSM / GPRS / EDGE with SIX LINEAR TRx SWITCH PORTS and DUAL-BAND TD-SCDMA

dimensions. Figure 5 provides a recommended phone board layout footprint for the FEM to help the designer attain optimum thermal conductivity, good grounding, and minimum RF discontinuity for the 50-ohm terminals.



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FIGURE 5. PHONE PCB LAYOUT FOR 6 mm x 6 mm, 28-PAD LEADLESS PACKAGE - SKY77590-51 SPECIFIC

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Package Description

Figure 6 shows the device pad configuration and the pad numbering convention, which starts with pad 1 in the upper left



Pad layout as seen from Top View looking through package.

FIGURE 6. SKY77590-51 PAD NAMES AND CONFIGURATION (TOP VIEW)

TABLE 12.	SKY77590-51	SIGNAL DESCRIPTIONS
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Pad ¹	Name	Description
9	Tx_HB_IN	Input Tx signal 1710 MHz–2025 MHz
10	Tx_LB_IN	Input Tx signal 824 MHz–915 MHz
11	BS2	Band Select
12	BS1	Band Select
13	VBATT	Battery supply voltage
14	VCC	Switch supply voltage
16	MODE	GMSK / EDGE / TD-SCDMA mode switch (0 = GMSK, 1 = EDGE / TD-SCDMA)
17	TxEN	Enable TxEN
18	VRAMP	Controls power in GSM mode and bias in EDGE/TD-SCDMA
19	TRx1	Wideband TRx switch port
20	TRx2	Wideband TRx switch port
21	TRx3	Wideband TRx switch port
22	TRx4	Wideband TRx switch port
23	TRx5	Wideband TRx switch port
24	TRx6	Wideband TRx switch port
26	ANT	PA output to Antenna
Ground Pad Grid		Ground Pad Grid (device underside)

¹ Pads 1-8, 15, 25, 27, 28 are ground pads.

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and increments counter-clockwise around the package. Table 16 lists the pad names and signal descriptions. Figure 7 illustrates the typical case markings.



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Package Handling Information

Because of its sensitivity to moisture absorption, this device package is baked and vacuum-packed prior to shipment. Instructions on the shipping container label must be followed regarding exposure to moisture after the container seal is broken, otherwise, problems relate to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY77590-51 is capable of withstanding an MSL3/260 °C solder reflow. Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. If the part is attached in a reflow oven, the temperature ramp rate should not exceed 3 °C per second; maximum temperature should not exceed 260 °C. If the part is manually attached, precaution should be taken to insure that the part is not subjected to temperatures exceeding 260 °C for more than 10 seconds. For details on attachment techniques, precautions, and handling procedures recommended by Skyworks, please refer to Skyworks Application Note: *PCB Design and SMT Assembly/Rework,* Document Number 101752. Additional information on standard SMT reflow profiles can also be found in the *JEDEC Standard J-STD-020.*

Production quantities of this product are shipped in the standard tape-and-reel format (Figure 8).

PRELIMINARY DATA SHEET

SKY77590-51 Tx-Rx FEM FOR QUAD-BAND GSM / GPRS / EDGE with SIX LINEAR TRx SWITCH PORTS and DUAL-BAND TD-SCDMA



NOTES:

- 1. PIN 1 ORIENTATION IS "TOP LEFT" ONLY FOR RFLGA & MCM PRODUCTS LISTED BELOW:
 - SKY73022-21 SKY73022-31 SKY73023-21 SKY73023-31
- 2. PIN 1 ORIENTATION IS "TOP RIGHT" FOR ALL 6 x 6 mm RFLGA & MCM PRODUCTS EXCEPT THOSE LISTED IN NOTE 1 ABOVE.
- 3. CARRIER TAPE IS BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
- 4. COVER TAPE IS TRANSPARENT AND CONDUCTIVE.
- 5. ESD-SURFACE RESISTIVITY IS ≤ 1 X 10¹⁰ OHMS/SQUARE PER EIA, JEDEC TNR SPECIFICATION.
- 6. ALL DIMENSIONS ARE IN MILLIMETERS.

CARRIER TAPE OVERMOLD MCM/RFLGA 6 x 6 x 0.85 / 1.1 mm BODY SIZE -193H XXXXXX_YYY

FIGURE 8. DIMENSIONAL DIAGRAM FOR CARRIER TAPE BODY SIZE 6 mm x 6 mm x 0.85 / 1.1 mm - MCM

Ordering Information

Product Name	Order Number	Evaluation Board Part Number
SKY77590-51 Tx-Rx Front-End Module	SKY77590-51	

Revision History

Revision	Date	Description
А	November 8, 2012	Initial Release – Preliminary Information

References

Skyworks Application Note: SKY77590 Rx-Tx Front-End Modules – Evaluation Board Information and Implementation, Document Number 202331

Skyworks Application Note: PCB Design and SMT Assembly/Rework, Document Number 101752

Standard SMT Reflow Profiles: JEDEC Standard J-STD-020

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